III. "Report on Phyto-Palæontological Investigations of the Fossil Flora of Alum Bay." By Dr. CONSTANTIN BARON ETTINGSHAUSEN, Professor in the University of Graz, Austria. Communicated by Professor HUXLEY, Sec. R.S. Received March 4, 1880.

The white clay of Alum Bay and the fossil plants included in it have been long known. The introduction to the "Monograph on the British Eocene Flora," Palæontographical Society, 1879, p. 12, gives a detailed history of this locality.

The first scientific investigation of the fossil plants of Alum Bay were made by Dr. De la Harpe and Professor Oswald Heer, who enumerated a Flora of about forty species, distributed in several genera.

I have devoted the winter 1879–80 to the investigation of this Fossil Flora at the British Museum, and I have had under examination for this purpose the fossil plants of Alum Bay collected by W. Stephen Mitchell and Mr. H. Keeping, the collections of the Woodwardian Museum at Cambridge, and those of the Museum of Practical Geology, and the collection of Mr. John Starkie Gardner.

The results of this investigation are as follow:—

The Fossil Flora of Alum Bay contains at least 116 genera and 274 species, which are distributed into 63 families. Of these genera 3 belong to the Thallophyta, 2 to the Filices, 5 to the Gymnospermæ, 6 to the Monocotyledons, 28 to the Apetalæ, 15 to the Gamopetalæ, 54 to the Dialypetalæ, and 2 are indeterminable.

A sub-tropical climate, at least, is indicated by many of the Ficus species, and by the Artocarpeæ, Cinchonaceæ, Sapotaceæ, Ebenaceæ, Büttneriaceæ, Bombaceæ, Sapindaceæ, Malpighiaceæ, etc.

The genera which are common to Alum Bay and Sheppey are: *Callitris, *Cupressinites, Sequoia, *Cyperites, Smilax, *Sabal, *Aronium, *Quercus, Juglans, *Laurus, Nyssa, Proteoides, Cinchonidium, Apocynophyllum, Sapotacites, *Diospyros, Symplocos, Magnolia, *Nelumbium, *Hightea, Acer, *Sapindus, *Cupania, Eugenia, *Eucalyptus, *Prunus, Amygdalus, *Podogonium, Leguminosites, *Carpolithes. In the genera to which an asterisk is prefixed, are found species common to Alum Bay and Sheppey. This great number of genera, common to Alum Bay and Sheppey, seems to point to such a close connexion between the two Floras, that it does not appear to me to be advisable to distinguish the leaves of the one from the fruits of the other, even though they cannot be absolutely connected, by separate specific names. I find it is possible, by comparing the leaves and fruits of their nearest living analogues, to unite them in many cases, at least provisionally. For instance, I find that the leaves of one of

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the Cupanias from Alum Bay approach nearly to those of the existing Cupania glabra, and I should prefer to unite with these Alum Bay leaves the form of Cupania fruit from Sheppey, which most nearly agrees with the same living species, namely, C. glabra, &c.

Liquidambar* and Metrosideros, which are common to Sheppey and Bournemouth, are as yet absent at Alum Bay; on the other hand, we have in Alum Bay the genera Symplocos, Nelumbium, and Hightea, which are common to this locality and Sheppey, but not yet found at Bournemouth.

The small number of ferns and palms, in comparison with the much greater number at Bournemouth and of the latter at Sheppey, is remarkable. This is attributable, I think, only to local physical conditions, and perhaps the same conditions may have led to the much greater prevalence of Dicotyledons in Alum Bay. In the beds of Studland, which are on the same horizon as Alum Bay, remains of palms and ferns abound, though belonging to few species.

Many of the Dicotyledons correspond with Miocene species, and I do not doubt that there is a genetic connexion between them. We have in Alum Bay the precursors of Quercus Lonchitis, Q. mediterranea, Ulmus longifolia, Celtis Japeti, Ficus lanceolata, F. sagoriana, F. arcinervis, F. Rüminiana, Juglans parschlugiana, Salix integra, Nyssa striolata, Grevillea Hæringiana, Persoonia laurina, Olea carneolica, Fraxinus primigenia, F. savinensis, Cinchonidium bilinicum, C. latifolium, Apocynophyllum Amsonia, Symplocos parschlugiana, Ceratopetalum bilinicum, C. radobojanum, Bombax chorisiæfolium, B. salmaliæfolium, Ternstrœmia radobojana, Acer decipiens, Dodonæa Salicites, D. Apocynophyllum, Celastrus Europæus, Ilex stenophylla, Vitis teutonica, Rhus stygia, Amygdalus œningensis, Palæolobium radobojense, Cassia Phaseolites, C. sagoriana, C. Memnonia, C. lignitum, C. stenophylla, Mimosites cassiæformis.

There are also what appear to be certain ancestral species, if I may use the expression, nearly allied to several miocene species, whose characters they unite; for instance, Hiræa intermedia connects H. borealis of the Fossil Flora of Hæring and H. Ungeri of the Fossil Flora of Sotzka; Celastrus Tafnis connects C. Æoli and C. Murchisoni; Celastrus Fenjæ connects C. cassinefolius and C. Bruckmanni; Celastrus Salidæ connects C. protogæus, C. Acherontis, C. deperditus from Hæring, C. Hippolyti from Kutschlin, C. oreophilus from Sotzka and C. stygius from Switzerland; Rhamnus acutangula connects R. paucinervis, R. colubrinoides, R. orbifera, R. œningensis, R. Graefii and R. Decheni; Cissus celastrifolia connects C. rhamnoides and C. celtidifolia; Rhus cyclophylla connects R. Pyrrhæ, R. Brunneri and R. Meriani.

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* The Alum Bay specimen called Liquidambar is only a less palmitid form of Aralia primigenia.

In addition to the great number of Miocene species, whose origin can apparently be traced back to the Eocene, there are not wanting indications that certain Miocene genera were not completely differentiated into genera in the Eocene period. For instance, the genus Castanea, perfectly developed in the Miocene, seems to be represented in the Eocene by a Castanea-like oak, Q. Bournensis, which combines in itself characters common to both genera, which are no longer found united. Another example is afforded by a Pomaderris-like Rhamnus, which, in like manner, seems to show the commencement of the differentiation of Pomaderris from Rhamnus, completed in the Miocene Flora.

I have selected for mention a few from among a great number of new forms, as possessing special interest.

A very distinct Marattia, nearly allied to M. Kaulfussi, J. Smith, is remarkable as being the first species met in the Tertiary. The Celtis is allied to C. Japeti of the Miocene Flora of Parschlug on the one side, and to the living C. australis on the other.

The only Adenopeltis is allied to an American living species. The presence of two species of Banksia is ascertained beyond all doubt, since their seeds also occur; many other leaves formerly named Banksia I now agree may belong to Myrica. The proteaceous Lomatia is represented by a fruit. Very characteristic leaves of Aristolochia and of Alyxia allied to the living Alyxia spicata R. Brown, and a Clerodendron allied to the East Indian C. viscosum Vent. are found, but rarely.

Of Diospyros is found calyx, berry and leaf, the berry occurring also in Sheppey. The solitary species of Diospyros of Alum Bay and that of Sheppey are the same. The only species of Cornus is remarkable as showing perhaps a genetic relation with some of the Miocene species. The leaves of two species of Malvaceæ belong, I think, to two of the species of Hightea from Sheppey, where eight species are found. One of the very characteristic leaflets of Bombaceæ may belong, on account of its venation and form, to the Brazilian genus Salmalia; and very characteristic leaves of Ternstrœmia, nearly allied to a Miocene form, are found. Of Cupania, the fruits of eight species of which are found at Sheppey, I have distinguished six species by their leaves in Alum Bay, and these I provisionally refer to the nearest of the Sheppey species. The only Alum Bay Pistacia is nearly allied to the well-known P. vera. The putamens of two species of Prunus, of which one is common to Sheppey occur, and of Amygdalus three species of fruits are found.

Of the Papilionaceæ I could distinguish thirty-eight species belonging to ten genera. The richest are Cassia and Dalbergia, and many species of them are also found in Hæring and Sotzka.

The comparison of the Fossil Flora of Alum Bay with that of Bournemouth and with the other Tertiary Floras is reserved until further investigations are completed. The most striking fact, however, in connexion with the Alum Bay Flora that my work even at this stage has brought out, is, that more than fifty of the species are common to Sotzka and Hæring, while a lesser number are common to Sézanne, the Lignitic of America, and to other Floras.

It is my pleasing duty to have again to acknowledge my thanks for the very important help the Royal Society has afforded me. I have also to acknowledge my indebtedness for advice and assistance to Sir Joseph Hooker, Dr. Henry Woodward, Mr. William Carruthers, Mr. T. G. Baker, Mr. R. Etheridge, jun., Professor T. M. K. Hughes, and Mr. J. S. Gardner.

Genera and Species of the Fossil Flora of Alum Bay.

THALLOPHYTA.

Rhytisma Eucalypti. *Ett. and Gard.*
,, priscum. *Ett. and Gard.*
Sclerotium antiquum. *Ett. and Gard.*

FILICES.

Chrysodium Lanzeanum. *Visian. sp.*
Anemia subcretacea. *Sap. sp.*
Marattia Hookeri. *Ett. and Gard.*

GYMNOSPERMÆ.

Cupressineæ.

Glyptostrobus Europæus. *Brongn. sp.*
Callitris curta. *Bowerb. sp.*
Cupressinites globosus. *Bowerb.*

Abietineæ.

Sequoia Langsdorfii. *Brongn. sp.*
Sequoia Couttsiæ. *Heer.*

Podocarpeæ.

Podocarpus eocenica. *Ung.*

MONOCOTYLEDONES.

Gramineæ.

Arundo Goepperti. *Münst. sp.*

Cyperaceæ.

Cyperites eocenicus. *Ett. and Gard.*

Smilaceæ.

Smilax lancifolia. *Ett. and Gard.*

Palmæ.

Sabal major. *Ung.*
Flabellaria. *sp. adhuc indeterm.*

Aroideæ.

Aronium eocenicum. *Ett. and Gard.*

DICOTYLEDONES.

APETALÆ.

Myriceæ.

Myrica salicina. *Ung.*
,, lignitum. *Ung.*
,, sagoriana. *Ett.*
Myrica Hæringiana. *Ung.*
,, acuminata. *Ung.*
Comptonia acutiloba. *Sternb. sp.*

Cupuliferæ.

Quercus Lyellii. *Heer.*
,, præ-lonchitis. *Ett. and Gard.*
,, lonchitis. *Ung.*
,, prae-mediterranea. *Ett. and Gard.*
Quercus drymeja. *Ung.*
,, Bournensis. *De la Harpe.*
,, viburnifolia. *Lesq.*
Fagus intermedia. *Ett. and Gard.*

Ulmaceæ.

Ulmus antiquissima. *Sap.*
,, plurinervia. *Ung.*
Planera Ungeri. *Ett.*

Celtideæ.

Celtis Woodwardi. *Ett. and Gard.*

Moreæ.

Ficus præ-lanceolata. *Ett. and Gard.*
,, lanceolata. *Heer.*
,, Morrisii. *De la Harpe.*
,, deleta. *Ett. and Gard.*
,, arenacea. *Lesq.*
,, præ-arcinervis. *Ett. and Gard.*
,, rhamnoides. *Ett. and Gard.*
,, Jynx. *Ung.*
,, Wudgæ. *Ett. and Gard.*
,, Falceroni. *Heer.*
Ficus bumeliæfolia. *Ett.*
,, Nerthi. *Ett. and Gard.*
,, Inguionis. *Ett. and Gard.*
,, planicostata. *Lesq.*
,, Reussii. *Ett.*
,, Cisæ. *Ett. and Gard.*
,, Bowerbankii. *De la Harpe.*
,, Granadilla. *Mass. sp.*
,, Hydrarchos. *Ung.*

Artocarpeæ.

Cecropia eocenica. *Ett. and Gard.*
Artocarpidium grandifolium. *Ett. and Gard.*
Artocarpidium integrifolium. *Ung.*

Juglandeæ.

Juglans præ-parschlugiana. *Ett. and Gard.*
Juglans Sharpei. *De la Harpe.*
Juglandites cernuus. *Sap.*

Euphorbiaceæ.

Adenopeltis Alumensis. *Ett. and Gard.*

Salicineæ.

Salix Rhedæ. *Ett. and Gard.*
,, præ-integra. *Ett. and Gard.*
Salix tenuifolia. *Ett. and Gard.*
Populus eocenica. *Ett. and Gard.*

Santalaceæ.

Santalum salicinum. *Ett.*
,, acheronticum. *Ett.*
,, osyrinum. *Ett.*
,, microphyllum. *Ett.*
Nyssa Alumensis. *Ett. and Gard.*
,, Europæa. *Ung.*
,, præ-striolata. *Ett. and Gard.*

Proteaceæ.

Proteoides crassipes. *Ett. and Gard.*
Grevillea Hermionis. ,, ,,
Persoonia eocenica. *Ett.*
Lomatia Britannica. *Ett. and Gard.*
Banksia Ungeri. *Ett.*
,, dillenioides. *Ett.*

Laurineæ.

Laurus primigenia. *Ung.*
,, ocoteides. *Lesq.*
,, Salteri. *De le Harpe.*
,, Agathophyllum. *Ung.*
,, Swozzowiciana. *Ung.*
,, Jovis. *De la Harpe.*
,, vetusta. *Sap.*
,, socialis. *Lesq.*
Laurus Lalages. *Ung.*
,, Haidingeri. *Ett.*
Cinnamomum Rossmæssleri. *Heer.*
,, polymorphum. *A. Braun. sp.*
,, eocenicum. *Ett.*
Daphnogene veronensis. *Mass. sp.*
,, anglica. *Heer.*

Daphnoideæ.

Daphne aquitanica. *Ett.*

Nyctagineæ.

Pisonia eocenica. *Ett.*

Aristolochieæ.

Aristolochia Alumensis. *Ett. and Gard.*

GAMOPETALÆ.

Cinchonaceæ.

Cinchonidium lanceolatum. *Ett. and Gard.*
Cinchonidium præ-bilinicum. *Ett. and Gard.*
Cinchonidium præ-latifolium. *Ett. and Gard.*

Oleaceæ.

Olea Britannica. *Ett. and Gard.*
Notelæa primigenia. *Ett. and Gard.*
Fraxinus Jovis. *Ett. and Gard.*
,, præ-savinensis. *Ett. and Gard.*

Apocynaceæ.

Alyxia Europæa. *Ett. and Gard.*
Apocynophyllum Titaniæ. *Ett. and Gard.*
Apocynophyllum grande. *Ett. and Gard.*
Apocynophyllum Hæringianum. *Ett.*
,, Præ-Amsonia. *Ett. and Gard.*

Convolvulaceæ.

Porana œningensis. *A. Braun.*

Verbenaceæ.

Clerodendron Europæum. *Ett. and Gard.*

Myrsineæ.

Myrsine Erdæ. *Ett. and Gard.*

Sapotaceæ.

Sapotacites eocenicus. *Ett. and Gard.*
,, emarginatus. *Heer.*
,, sideroxyloides. *Ett.*
Bumelia Oreadum. *Ung.*
,, Dryadum. *Ett. and Gard.*

Ebenaceæ.

Diospyros eocenica. *Ett. and Gard.*

Symploceæ.

Symplocos Britannica. *Ett. and Gard.*

Vaccinieæ.

Vaccinium eocenicum. *Ett. and Gard.*
Vaccinium acheronticum. *Ung.*

Ericaceæ.

Andromeda protogæa. *Ung.*

DIALYPETALÆ.

Araliaceæ.

Aralia primigenia. *De la Harpe.*

Corneæ.

Cornus atlantica. *Ett. and Gard.*

Saxifragaceæ.

Callicoma Fornacis. *Ett. and Gard.*
Ceratopetalum crassipes. *Ett. and Gard.*
Ceratopetalum Manni. *Ett. and Gard.*
,, Hæringianum. *Ett.*

Nymphæaceæ.

Nelumbium Buchii. *Ett.*
Nymphæa Doris. *Heer.*

Magnoliaceæ.

Magnolia stygia. *Ett. and Gard.*

Anonaceæ.

Anona elongata. *Ett. and Gard.*
Anona cyclosperma. *Ett. and Gard.*

Büttneriaceæ.

Pterospermum eocenicum. *Ett. and Gard.*
Pterospermites dentatus. *Ett. and Gard.*

Malvaceæ.

Hightea elliptica. *Bowerb.*
Hightea turbinata. *Bowerb.*

Bombaceæ.

Bombax Menjæ. *Ett. and Gard.*
,, Sagorianum. *Ett.*
,, tenuinerve. *Ett. and Gard.*
Salmalia borealis. *Ett. and Gard.*
Sterculia Labrusca. *Ung.*
,, Sigfridi. *Ett. and Gard.*

Ternstrœmiaceæ.

Ternstrœmia eocenica. *Ett. and Gard.*
,, bilinica. *Ett.*
Saurauja robusta. *Sap.*

Tiliaceæ.

Grewiopsis integerrima. *Ett. and Gard.*

Acerineæ.

Acer eocenicum. *Ett and Gard.*
Acer præ-decipiens. *Ett. and Gard.*

Sapindaceæ.

Sapindus eocenicus. *Ett. and Gard.*
,, angustifolius. *Lesq.*
,, falcifolius. *A. Braun.*
,, crassinervis. *Ett. and Gard.*
Cupania lobata. *Bowerb.*
,, subangulata. *Bowerb.*
Cupania tumida. *Bowerb.*
,, depressa. ,,
,, corrugata. ,,
,, grandis. ,,
Dodonea præ-salicites. *Ett. and Gard.*
,, subglobosa. ,, ,,

Malpighiaceæ.

Hiræa intermedia. *Ett. and Gard.*
Malpighiastrum grandifolium. *Ett. and Gard.*
Malpighiastrum banisterinum. *Ett. and Gard.*
Malpighiastrum præ-venosum. *Ett. and Gard.*

Cedrelaceæ.

Cedrela primigenia. *Ett. and Gard.*

Pittosporeæ.

Pittosporum eocenicum. *Ett. and Gard.*

Celastrineæ.

Celastrus Tafnis. *Ett. and Gard.*
,, Fengæ. ,, ,,
,, salidæ. ,, ,,
,, elænus. *Ung.*
,, præ-europæus. *Ett. and Gard.*
Celastrus myricinus. *Ett. and Gard.*
Elæodendron dubium. *Ett.*
Celastrophyllum undulatum. *Ett. and Gard.*

Ilicineæ.

Ilex Atlantica. *Ett. and Gard.*

Rhamneæ.

Zizyphus Ungeri. *Heer.*
,, vetustus. ,,
,, integrifolius. *Heer.*
,, pachyneuris. *Ett. and Gard.*
Rhamnus acutangula. *Ett. and Gard.*
,, præ-rectinervis. ,, ,,
,, præ-pomaderris. *Ett. and Gard.*

Ampelideæ.

Cissus Auroræ. *Ett. and Gard.*
,, celastrifolia ,, ,,
Vitis præ-teutonica. *Ett. and Gard.*

Anacardiaceæ.

Rhus cyclophylla. *Ett. and Gard.*
,, Atlantidis. ,, ,,
Rhus prisca. *Ett.*
Pistacia Britannica. *Ett. and Gard.*

Myrtaceæ.

Eugenia Apollinis. *Ung.*
Eucalyptus oceanica. *Ung.*
,, Hæringiana. *Ett.*
Myrtus eocenica. *Ett and Gard.*
Callistemophyllum obtusum. *Ett. and Gard.*
Callistemophyllum elegans. *Ett. and Gard.*
,, melaleucæforme. *Ett.*
,, diosmoides. *Ett.*

Amygdaleæ.

Prunus Druidum. *Ett. and Gard.*
,, Pygmæorum. *Ett. and Gard.*
Amygdalus tenue-striata. ,, ,,
Amygdalus præ-œningensis. *Ett. and Gard.*
Amygdalus pereger. *Ung.*

Papilionaceæ.

Glycyrrhiza deperdita. *Ung.*
Physolobium orbiculare. ,,
,, antiquum. ,,
Phaseolites eriosemæfolius. ,,
Dalbergia primæva. ,,
,, Hæringiana. *Ett.*
,, Ungeri. ,,
,, cyclophylla. *Ett. and Gard.*
,, longifolia. ,, ,,
,, eocenica. *Ung. sp.*
Palæolobium Sotzkianum. *Ung.*
,, Hæringianum. ,,
,, heterophyllum. ,,
,, præ-radobojense. *Ett. and Gard.*
Sophora Europæa. *Ung.*
Cæsalpinia æmula. *Heer.*
,, Haidingeri. *Ett.*
Cassia præ-phaseolites. *Ett. and Gard.*
,, Phaseolites. *Ung.*
,, Berenices. ,,
Cassia hyperborea. *Ung.*
,, Fischeri. *Heer.*
,, Ungeri. *De la Harpe.*
,, præ-memnonia. *Ett. and Gard.*
,, Memnonia. *Ung.*
,, præ-sagoriana. *Ett. and Gard.*
,, Sagoriana. *Ett.*
,, pseudoglandulosa. *Ett.*
,, Feroniæ. ,,
,, Zephyri. ,,
,, præ-lignitum. *Ett. and Gard.*
,, præ-stenophylla. ,, ,,
Copaifera prisca. ,, ,,
,, Harpei. ,, ,,
,, Veledæ. ,, ,,
Podogonium Sheppyense. *Ett. and Gard.*
,, obtusissimum. ,, ,,
Leguminosites callisemæfolius. *Ett. and Gard.*
Leguminosites pachyphyllus. *Ett. and Gard.*

Mimoseæ.

Acacia Sotzkiana. *Ung.*
,, Britannica. *Ett. and Gard.*
Mimosites præ-cassiæformis. *Ett. and Gard.*

PLANTÆ INCERTÆ SEDIS.

Carpolithes elliptico-valvatus. *Ett. and Gard.*
Carpolithes tricoccinus. *Ett. and Gard.*
,, Napæarum. ,, ,,
,, Alumensis. ,, ,,
,, præ-boveyanus. ,, ,,
,, crassipes. ,, ,,
Phyllites cecropioides. ,, ,,
,, ficoides. ,, ,,
,, lantanoides. ,, ,,
,, apocynoides. ,, ,,
,, crassipes. ,, ,,
,, densinervis. ,, ,,
,, Nimrodis. ,, ,,
,, elæocarpoides. ,, ,,
Phyllites syringæformis. *Ett. and Gard.*
,, hederaceus. ,, ,,
,, arbutoides. ,, ,,
,, euphorbioides. ,, ,,
,, Gargantuæ. ,, ,,
,, myrtaceus. ,, ,,
,, Nerthi. ,, ,,
,, franguloides. ,, ,,
,, Veledæ. ,, ,,
,, Freæ. ,, ,,
,, sapindoides. ,, ,,
,, Hilticis. ,, ,,
,, simaruboides. ,, ,,
,, hymenæoides. ,, ,,